BEAN GERMPLASM CONSERVATION BASED ON SEED DRYING WITH SILICA GEL AND LOW MOISTURE STORAGE

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Abstract

Preservation of germplasm collections with low temperature storage is problematic because of power failures and equipment breakdown. Low moisture storage is an alternative to low temperature storage for medium-term germplasm conservation of seeds of most crops. Seed drying using silica gel for medium-term storage of bean seed was investigated. Seeds of two bean cultivars were dried for 50 days with silica gel in a desiccator experiment using a gel to seed ratio of 1:2. The final moisture content was 6.1 and 6.6% for the two cultivars. Dry seeds were stored in recycled glass soda bottles with screw caps sealed with candle wax at 25°C for one year. The seed moisture content remained constant confirming that recycled glass soda bottles can be used as inexpensive seed storage containers. Germination rates after one year of storage were 97.5 and 100% for the two cultivars. It is expected that the seed can be kept in glass bottles for 10-20 years (mid-term storage). In order to dry larger amounts of seed, a low cost drying facility using silica gel in an air-tight PVC drum was developed.

Introduction. Like many other germplasm collections, the Uganda bean germplasm was stored until recently at ambient conditions (13-14% moisture content, 25°C). Regeneration of all accessions every two to three seasons was required to retain seed viability. Apart from the heavy workload, too frequent regeneration bears the risk of genetic drift and loss of accessions due to unfavorable weather conditions, insect pests and diseases.On the other hand, low temperature storage commonly used in genebanks is expensive and problematic where power supply is unreliable and equipment breakdown frequent. It is not uncommon that whole collections are lost due to these problems.

This paper investigates the feasibility and the technicalities of a low cost technology for bean seed drying with silica gel as well as for seed storage.

Materials and methods. Two seed samples of 125 g of the bean cultivars White Haricot (22 g/100 seeds) and Rubona 5 (38 g/100 seeds) were dried to 6.0-6.5% moisture content (MC) in a desiccator with a silica gel to seed ratio of 1:2. The desiccator was kept at 25°C. Silica gel with a color-changing ability (containing cobalt chloride) was replaced by the same amount of dry silica gel when 50-75% of the gel had changed its color. Seed MC was determined through weight loss after 10, 25 and 50 days. Dry seeds were put into recycled glass soda bottles (250 ml) with plastic screw caps and the bottles were sealed with candle wax. The bottles were then stored at 25°C. Seed MC was monitored through weighing every month over a period of one year. Germination tests were carried out seven months and one year after bottling. Prior to germination, forty seeds were rehydrated at ambient conditions (25°C; 70-90% relative humidity) for 2 and 6 days after storage of seven months and one year, respectively (imbibition damage at the first test suggested need for a longer rehydration period). In order to handle larger amounts of seed a high density polyvinyl chloride (PVC) open head drum (diameter 0.45 m, height 0.75 m, volume 0.12 m^3) with an air-tight seal was fitted with a metal cylindrical grill construction to hold silica gel in the center of the drum. The 20 cm diameter of the cylinder allows for a silica gel to seed ratio of approximately 1:2 (maximum 16 kg of seed and 8 kg of silica gel). Cloth bags of silica gel are put in the center and cloth bags of seed around the central cylinder. Two rings near the periphery prevent over-packing of the seeds and allow good air-circulation. The silica gel was removed for drying and replaced by an equal amount when about 25% of the silica gel had lost its dark blue color.

Results and discussion. Seed MC of White Haricot and Rubona 5 dropped from 13.8% (seed equilibrium MC) to 6.1% and 6.6%, respectively, after 50 days of drying over silica gel. The silica gel had to be replaced four times during this period. The long drying period may be due to the relatively large seed size, the thick seed coat and the high protein content of bean seed. A more frequent replacement of the silica gel would decrease the drying period. Zhang and Tao (1989) indicate that 30-34 days are required to dry bean seeds from 14% to 5% MC using a silica gel to seed ratio of 1:2 replacing the silica gel when 12-23% of the silica gel had changed its colour. Alternatively, silica gel to seed ratios of 1:1 up to 3:1 could be used. However, when seeds are dried too fast physiological and mechanical damage to the seed can occur, especially if initial seed moisture is higher than 50% (Zhang and Tao, 1989).

Dry seeds stored for seven months in sealed glass bottles had a germination rate of 98% and 86% for Rubona 5 and White Haricot, respectively, compared to 100% and 98%, respectively, for un-dried seed. When seeds were rehydrated at ambient conditions for 6 days instead of 2 days the germination rate after one year of storage was comparable to the non-dried seed. The lower germination rate at seven months was probably a result of imbibition damage rather than seed deterioration *per se*. These results confirm findings of Zhang and Tao (1989) who did not observe a significant decrease in germination and vigour after bean seeds had been stored at 6.3% MC at 10-20 and 40°C for six months. After one year of storage there was no difference in germination rates of dried seeds and seeds kept at seed equilibrium moisture content. However, with time the germination rate for non-dried seed is expected to decrease faster than for dried seed since deterioration of non-dried seed occurs at a faster rate.

Using the PVC drum bean seeds were successfully dried to 6.4% MC during a period of nine weeks, while replacing the silica gel nine times. A shorter drying time can be achieved if the silica gel is replaced more frequently. Alternatively, a silica gel to seed ratio of 1:1 could be used but the cost will be increased as silica gel, while reusable, is the costly component of this technology. To further reduce costs, the indicating silica gel could be mixed with the cheaper non-indicating type at a ratio of 1:10.

Conclusions. Bean seeds can be successfully dried to 6% MC using silica gel without loosing seed viability provided the seeds are rehydrated for 6 days prior to germination tests. Recycled glass soda bottles sealed with candle wax proved to be air-tight. They are an inexpensive alternative to other seed storage containers or laminated aluminum bags. The seed drying facility using an air-tight PVC drum is relatively inexpensive, easy to manage and power independent apart from the regeneratin of the silca gel. A disadvantage is the frequent replacement of the silica gel.

References and further reading

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